National Aeronautics and Space Administration

A Catalog of NASA-Related Case Studies

Compiled by the Office of the Chief Knowledge Officer
Goddard Space Flight Center, NASA

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Cover Image: NFIRE, Credit: NASA

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NASA Safety Center (NSC)

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Center for Systems Engineering, Air Force Institute of Technology

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Case Title	AGATE: The Turning Point for General Aviation
Project Name	AGATE
Source	Virginia Polytechnic Institute
URL	http://www.nasa.gov/pdf/293210main_58527main_agate_casestudy_042604.pdf
# of Pages	35
Abstract	This is a full length historical case of how NASA became involved in a project to revitalize the General Aviation industry in America which had been declining for 15 years. Set in the early 1990s it documents the steps and involvement of the government through AGATE to address this decline. AGATE is the Advanced General Aviation Transportation Experiments.
Subject Focus	project management; revitalizing industry
Learning Points	Industrial decline and revitalization. Government intervention. National technology capability.
Other Resources	AGATE factsheet: http://www.nasa.gov/centers/langley/news/factsheets/AGATE.html

Case Title	Atlas Centaur-67: Go or No Go for Launch?
Project Name	AC-67
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	3
Abstract	Thunderstorms are building near the launch facility at Cape Canaveral, Florida, when countdown commences for the Atlas Centaur-67 mission. Prior to AC-67, with its military communications satellite payload, the Atlas Centaur rocket had been deployed in 66 consecutive NASA missions. The launch team debates ambiguous weather and safety launch criteria as problems with communications equipment, and a small launch window for an eager customer, complicate the go/no-go decision in the final moments of countdown.
Subject Focus	launch decision
Learning Points	The importance of understanding the origin and context of safety requirements. When operating near the limit of specifications, extra caution needs to be added if the requirements are not well understood. If things look really bad, they might be really bad. How to speak up in a fast-paced, high pressure environment (launch).
Other Resources	Christian, H. J., V. Mazur, B. D. FIsher, L. H. Ruhnke, K. Crouch, and R. P. Perala (1989), The Atlas/Centaur Lightning Strike Incident, J. Geophys. Res., 94(D11), 13,169–13,177.

Case Title	Building the Team: The Ares I-X Upper Stage Simulator
Project Name	ARES
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/352126main_Ares_I-X_Case_Study.pdf
# of Pages	10
Abstract	The opportunity to build a new launch vehicle that can lift humans into space does not come along often. The Ares family of launch vehicles, conceived in response to the Vision for Space Exploration, presented the first chance for NASA engineers to get hands-on experience designing and building human spacecraft hardware since the development of the Space Shuttle thirty years ago. In 2005, NASA Headquarters solicited proposals from Integrated Product Teams for different segments of the Ares I-X test flight vehicle. A team at Glenn Research Center won the bid for the job of building the Ares I-X Upper Stage Simulator (USS). A fabrication job of this size required not only renovation of some facilities but also putting a team together with the right mix of skills.
Subject Focus	expertise; facilities renovation; large scale fabrication; staffing; retraining
Learning Points	The organizational context of a NASA center can determine the types of challenges faced by a project manager; Project leaders may be required to employ a number of strategies and tactics to adjust the composition of the team in order to get to the right results; professional development activities may play a key role in the makeup of the final team?.
Other Resources	http://spaceflightsystems.grc.nasa.gov/LaunchSystems/Simulator/ http://askmagazine.nasa.gov/pdf/pdf34/NASA_APPEL_ASK_34s_building_the_team.pdf

Case Title	Columbia's Final Mission
Project Name	STS-107
Source	Harvard Business School Publishing
URL	http://hbr.org/product/columbia-s-final-mission/an/304090-PDF-ENG?Ntt=columbia
# of Pages	33
Abstract	Describes the 16-day final mission of the space shuttle Columbia in January 2003 in which seven astronauts died. Includes background on NASA and the creation of the human space flight program, including the 1970 Apollo 13 crisis and 1986 Challenger disaster. Examines NASA's organizational culture, leadership, and the influences on the investigation of and response to foam shedding from the external fuel tank during shuttle launch.
Subject Focus	shuttle accident; decision-making; communication; crisis management;
Learning Points	To analyze the flawed response to an ambiguous but potentially threatening signal during a period in which recovery of the shuttle was possible. (Source: HBR)
Other Resources	Remembering Columbia (NASA History website): http://history.nasa.gov/columbia/index.html

Case Title	Columbia's Final Mission (Multimedia case)
Project Name	STS-107
Source	Harvard Business School Publishing
URL	http://hbsp.harvard.edu/multimedia/columbia/305032/html_bundle/index.html
# of Pages	n/a
Abstract	On February 1, 2003, the Shuttle Columbia disintegrated upon re-entry into the Earth's atmosphere, and the seven astronauts onboard lost their lives. Explores Columbia's final mission from the perspective of six key managers and engineers associated with NASA's Space Shuttle Program. An introductory video and interactive timeline present background information. An application replicates the desktop environment of six real-life managers and engineers involved in decision making during the period prior to Columbia's re-entry. Each student is preassigned a particular role and, through a password system, enters the role-play application. Students review the protagonists' actual e-mails, listen to audio re-enactments of crucial meetings, and review space agency documents. Students must be prepared to play the role of the protagonist in a classroom re-enactment of a critical Mission Management Team meeting that took place on Flight Day 8 (January 24, 2003). Students examine the organizational causes of the tragedy rather than focus on the technical cause.
Subject Focus	beliefs, crisis communication, crisis prevention, group behavior, group dynamics, managerial skills
Learning Points	To enhance understanding of organizational decision making and learning as well as catastrophic failures; to help students understand how failures can evolve; to think about how to prevent failures in an organization; and to examine how to manage crises effectively. Also, to learn leadership behavior and how to build an organization that is less susceptible to significant preventable failures.
Other Resources	Michael A. Roberto, Richard Bohmer, Amy C. Edmondson, Facing Ambiguous Threats, R0611F-PDF-ENG.

Case Title	Cover Blown - The WIRE Spacecraft Mishap
Project Name	WIRE
Source	NASA Safety Center (NSC)
URL	http://pbma.nasa.gov/docs/public/pbma/images/msm/WIRE_SFCS.pdf
# of Pages	4
Abstract	Launched on March 4, 1999, the Wide-Field Infrared Explorer (WIRE) carried an infrared telescope that was meant to study the formation of galaxies. To prevent the satellite's heat from interfering with faint infrared signals, the telescope was stored in a cryostat cooled by tanks of frozen hydrogen. Approximately twenty minutes after WIRE separated from its launch vehicle, a transient electronic signal released the cryostat cover, exposing the hydrogen tanks to heat from the sun and earth. The hydrogen sublimated and escaped through the vents, sending the spacecraft into an uncontrolled spin. In less than thirty-six hours, the entire four-month supply of solid hydrogen needed to cool the telescope's infrared sensors was gone.
Subject Focus	on-orbit failure; test-as-you-fly; peer reviews
Learning Points	Underlying issues identified by the Mishap Investigation Board (MIB) included the following: 1) Failure to consider off-nominal conditions; 2) Lack of peer reviews; 3) Incomplete test procedures and analysis.
Other Resources	Listed at the end of the case study document

Case Title	Earth Observing System Data Information System (EOSDIS)
Project Name	EOSDIS
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/384155main_EOSDIS_case_study.pdf
# of Pages	35
Abstract	The Earth Observing System Data and Information System (EOSDIS) was started as part of the Earth Observing System (EOS). This system was meant to collect, process, distribute, and archive the large amount of data that was to be generated by the EOS program and to archive and distribute NASA Earth science data. The purpose of this case study on EOSDIS is to help NASA managers, engineers, and scientists understand what happened during the implementation of the EOSDIS in order to be able to apply the lessons learned to future programs and projects.
Subject Focus	R&D environment vs. operational environment; developers vs. users; instability of requirements; acquisition strategy
Learning Points	1) Don't overreact or let the pendulum swing too far in the other direction; 2) Know what you want to build and be able to define it; 3a) Acquisition strategy must be tailored to any system where the user needs are difficult to articulate and subject to technological evolution and enhancement; 3b) A build-it-by-the-yard approach is desirable to maintain cost control while allowing flexibility for evolutionary changes; 3c) Flexible options must be available for the outer concentric developments; 4) Control expectations; tell the truth about capabilities; 5) Choose the appropriate organizational structure, staff it accordingly, and stay with it; 6) Keep the flight operating system (FOS) tied to the flight segment; 7) A strong systems engineering capability is needed for large, complex system development; 8) If the underlying processes are not in place, you don't have a chance; 9) Program, Project, and executive leadership must be aware of the environment; 10) Strong leadership, at all levels, is criticial to the development of a new, complext, highly-visible system; 11) Maintaining partnerships between the teams is necessary for a successful development; 12) A large government program with high visibility draws political attention that can impact development; 13) Endless reviews do not help a struggling project.
Other Resources	References are listed at the end of the case document.

Case Title	Fender Bender - DART's Automated Collision
Project Name	DART
Source	NASA Safety Center (NSC)
URL	http://pbma.nasa.gov/docs/public/pbma/images/msm/DART_SFCS.pdf
# of Pages	4
Abstract	The Demonstration of autonomous Rendezvous Technology (DART) program intended to demonstrate that a spacecraft could independently rendezvous with an orbiting satellite without human intervention. The DART spacecraft was successfully launched in April 2005. Following a series of navigational system errors and problems with fuel management, DART crashed into its rendezvous partner spacecraft.
Subject Focus	navigational system error; on-orbit failure
Learning Points	Underlying issues included 1) Flawed software requirements and validation approach; 2) Ineffective design choices, and; 3) Lack of training, experience and oversight. The mission illustrated the importance of independent assessments, audits, and peer reviews throughout the various stages of a mission.
Other Resources	Listed at the end of the case study document.

Case Title	Final Voyage of the Challenger
Project Name	STS-51L
Source	Harvard Business School Publishing
URL	http://hbr.org/product/final-voyage-of-the-challenger/an/691037-PDF-ENG
# of Pages	35
Abstract	On January 28, 1986, seven astronauts were killed when the space shuttle they were piloting, the Challenger, exploded just over a minute into the flight. The failure of the solid rocket booster O-rings to seat properly allowed hot combustion gases to leak from the side of the booster and burn through the external fuel tank. The failure of the O-ring was attributed to several factors, including faulty design of the solid rocket boosters, insufficient low- temperature testing of the O-ring material and the joints that the O-ring sealed, and lack of proper communication between different levels of NASA management. The case "provides a summary of technical and organizational details that led to the decision to launch the Challenger Space Shuttle, and to the ensuing accident.
Subject Focus	shuttle accident; decision-making; risk management
Learning Points	Details of design and testing milestones of the Space Shuttle, with a focus on the Solid Rocket Booster, offer opportunities for project management and organizational analysis. NASA's risk management structure and its use for the Space Shuttle program exposes students to issues of risk associated with the use of technology. Principles of engineering versus managerial decision making, the role of professional knowledge, and issues related to data representation, and qualitative versus quantitative analysis are addressed. Some issues of professional ethics and individual responsibilities, as related to complex decision making in a technology intensive environment are presented in a context of a crisis situation. The analysis of the case should include assessment of project management, and ideas about organizational changes to avoid recurrence." (Source: HBR website)
Other Resources	STS-51L Challenger Accident (NASA History website): http://history.nasa.gov/sts51l.html

Case Title	Fire in the Cockpit - The Apollo 1 Tragedy
Project Name	Apollo 1
Source	NASA Safety Center (NSC)
URL	http://pbma.nasa.gov/docs/public/pbma/images/msm/Apollo_SFCS.pdf
# of Pages	4
Abstract	A seminal event in the history of human spaceflight occurred on the evening of January 27th, 1967, at Kennedy Space Center (KSC) when a fire ignited inside the Apollo 204 spacecraft during ground test activities. The 100% oxygen atmosphere, flammable materials and a suspected electrical short created a fire that quickly became an inferno. Virgil Grissom, Edward White II, and Roger Chaffee (the prime crewmembers for Apollo mission AS-204 -- later designated Apollo 1) perished in the flames before the hatch could be opened.
Subject Focus	design and material issues; quality control; emergency preparedness; budget and schedule pressures; complacency
Learning Points	The Apollo 1 case study is particularly important for NASA to consider in development of designs for the Orion spacecraft and Ares family of booster rockets. The Apollo 1 case demonstrates how previous success with a recognized, but not properly mitigated condition, can lull managers, designers and operators into complacency. The case also underscores the need to understand material properties across the full range of operating environments. Finally, the case illustrates how solutions to one problem can become the source of new problems.
Other Resources	Listed at the end of the case study document

Case Title	Goddard Space Flight Center: Building A Learning Organization
Project Name	n/a
Source	Darden, University of Virginia
URL	https://store.darden.virginia.edu/business-case-studies
# of Pages	20 (Case A) + 12 (Case B)
Abstract	While reading the Wall Street Journal, Edward Rogers notices an advertisement for a Knowledge Management Architect at the Goddard Space Flight Center in Greenbelt, Maryland. Rogers is an academic whose scholarship centers on developing models of how and why people cooperate intellectually. After submitting his résumé and completing the interview process, Rogers is offered the position for a term appointment of three years. After one month on the job, Rogers wonders how he should proceed in helping the Goddard Space Flight Center become a learning organization. It is, in fact, the kind of opportunity Rogers has looked forward to for many years, but what will his plan of attack look like? How can he help this collection of rocket scientists work better together? The A case presents an undisguised picture of a NASA center that is fostering a learning approach to developing the organization. In the B case, Rogers's action plan is presented, together with input from NASA engineers, scientists and other key players. See also the A case (UVA-OB-0833).
Subject Focus	organizational learning; knowledge management
Learning Points	
Other Resources	OCKO website: http://www.nasa.gov/goddard/ocko

Case Title	GOES-N: Long and Winding Road to Launch
Project Name	GOES-N
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	8
Abstract	GOES-N was built to be the most advanced meteorological satellite in space, the first in the next generation of "geostationary operational environmental satellites." Getting GOES-N into orbit is proving to be extremely difficult. For months in 2005-06, during a string of delays and resets due to lightning strikes to the rocket and strikes by contractor technicians, the satellite has sat on the pad while project managers wrestle with launch issues: on-ground duration without systems retesting, whether to de-stack, and when an observatory and spacecraft have been on the launch pad too long.
Subject Focus	managing fixed-price contract; technical role in launch decision; managing exigencies
Learning Points	The role of the Systems Engineer to marshal the project towards launch. How engineering (technical) issues spill over into procurement (contract) issues. Implications of a fixed price delivery contract for space missions and launch services. Making judgment calls on equipment readiness.
Other Resources	GOES-N Web page: http://www.nasa.gov/mission_pages/goes-n/main/

Case Title	Gravity Probe B
Project Name	GP-B
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/384132main_Gravity_Probe_B_case_study.pdf
# of Pages	11
Abstract	In the summer of 2003, NASA Program Manager Rex Geveden was eager to ship the Gravity Probe B (GP-B) spacecraft to Vandenberg Air Force Base for integration and testing and then launch. In April the program had undergone a termination review, which in Geveden's estimation, had been a close call. Getting the spacecraft to the launch pad would remove the threat of imminent cancellation. After the spacecraft arrives at Vandenberg, problems with the Experimental Control Unit (ECU) are identified. Will these problems require the launch to be postponed until the issues are satisfactorily addressed?
Subject Focus	schedule pressures; launch decisions; risk management; risk mitigation
Learning Points	Different types of pressures can affect the behavior of key stakeholders. Different stakeholders can characterize anomalies differently in risk management terms. Various organizational and managerial factors can complicate the decision-making process for the program manager.
Other Resources	Gravity Probe B website at Stanford University: http://einstein.stanford.edu/; NASA Mission Page: http://www.nasa.gov/mission_pages/gpb/index.html

Case Title	HMS Thetis and Apollo XIII
Project Name	Apollo XIII
Source	Harvard Business School Publishing
URL	http://hbr.org/product/hms-thetis-and-apollo-xiii/an/696097-HCB-ENG
# of Pages	21
Abstract	Explores the management of technical disasters in which time plays a central role. Uses the experience of HMS Thetis and Apollo 13 to look at both successful and unsuccessful approaches.
Subject Focus	disaster management
Learning Points	
Other Resources	

Case Title	Hubble Space Telescope: Systems Engineering Case Study
Project Name	HUBBLE
Source	Center for Systems Engineering, Air Force Institute of Technology
URL	http://www.afit.edu/cse/csdl.cfm?case=18&p=0&file=Hubble SE Case Study.pdf
# of Pages	69
Abstract	This is a full length case exploring in depth the systems engineering challenges of building the Hubble Space Telescope. The issue of the mirror is dealt with and why it was missed in development and build. The case explains the various instruments and has detailed photos and charts. References are made to the NASA systems engineering guidebook which has since been updated.
Subject Focus	systems engineering
Learning Points	Early and full participation of customer is essential. Pre-program trade studies can help keep early discussions focused on technical considerations when political concerns are trying to play with the project. Systems integration and testing need to be a significant portion of program resources. Life cycle support is critical from day one. Number of players introduces risk that needs to be addressed.
Other Resources	Hubble website: http://hubble.nasa.gov/

Case Title	IBEX: Managing Logistical Exigencies
Project Name	IBEX
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	1
Abstract	The Interstellar Boundary Explorer (IBEX) will provide images that will reveal properties of the interstellar boundaries that separate our heliosphere from the local interstellar medium. When the time comes to move IBEX and its attached rocket assembly the 15 miles to the launch pad, it becomes obvious that it will not fit in the moving container. The fall-back—double-bagging the assembly in plastic—is for much shorter trips. Numerous risks are considered.
Subject Focus	logistics, communication
Learning Points	Just because it says somewhere it can be done, doesn't mean that it's the right thing to do. How can a safety officer push back and get support for an unpopular but safety first decision? The responsibility to protect flight hardware.
Other Resources	IBEX website: http://ibex.swri.edu/

Case Title	IMAGE
Project Name	IMAGE
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/flash/293122main_image_study.swf
# of Pages	n/a – self-learning multimedia presentation
Abstract	In this interactive case study you will be presented with a real management situation faced by the NASA-contracted Southwest Research Institute team during the groundwork of the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) mission. As the Project Manager you will need to respond in the most effective and timely manner possible. Your decision will directly affect the outcome of the entire mission. When faced with the following problems, you will want to respond as a Project Manager and to think about ways that you can encourage your team to do the same.
Subject Focus	budget; schedule; science; team; project management
Learning Points	
Other Resources	IMAGE Mission website: http://image.gsfc.nasa.gov/

Case Title	International Project Management: The Cassini-Huygens Mission
Project Name	CASSINI-HUYGENS
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/offices/oce/appel/knowledge/publications/cassini.html
# of Pages	14 (slides)
Abstract	The Cassini-Huygens Mission is a United States/European mission to explore the ringed planet. NASA and the Italian Space Agency developed the Cassini spacecraft, and the European Space Agency (ESA) designed and built the Huygens probe. Cassini-Huygens was launched October 1997 on a 6.7-year voyage to Saturn. A failure in Cassini's telemetry system as the spacecraft approached Saturn, after a multi-year journey through deep space, posed a critical problem for the mission management team.
Subject Focus	on-orbit failure; telemetry; international collaboration; ITAR
Learning Points	This NASA mini-Case Study looks at the programmatic and technical complexities of an international deep-space mission in which there is zero room for error. It elucidates some of the mission's primary challenges and their solutions.
Other Resources	Cassini Equinox Mission (JPL website): http://saturn.jpl.nasa.gov/ Cassini-Huygens (ESA website): http://www.esa.int/SPECIALS/Cassini-Huygens/index.html

Case Title	Launching New Horizons: The RP-1 Tank Decision
Project Name	New Horizons
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/337384main_New_Horizons_RP!_Tank_Case_Study.pdf
# of Pages	16
Abstract	Four months before the planned launch of the New Horizons mission to Pluto (scheduled for January 2006), the manufacturer of the launch vehicle reported that its fuel tank experienced a failure during the final stages of qualification testing. The questions raised by this failure ultimately presented a test case for the agency's recently revamped governance model. The programmatic, engineering, and safety communities had fundamental disagreements about difficult technical questions, which ultimately led to an appeal to the NASA Administrator.
Subject Focus	governance model; independent technical authority; transparent decision making
Learning Points	One of the most vigorous and healthy discussions at NASA over the past several years has concerned the establishment of the formal process for ensuring that dissenting opinions receive a full and fair hearing. That process, now codified in NASA Procedural Requirement (NPR) 7120.5D: NASA Space Flight Program and Project Management Requirements, applies to unresolved issues of any nature (technical, programmatic, safety, or other), and delineates an orderly way of raising difficult issues and, when necessary, elevating them to higher levels of management for resolution.
Other Resources	NASA Mission page: http://www.nasa.gov/mission_pages/newhorizons/main/index.html

Case Title	Launching the Vasa
Project Name	VASA
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	8
Abstract	The 17th-century warship Vasa sank upon launch with great loss of life owing to many political, and engineering development factors. This lessons from this historic example are used as a prescriptive warning for large projects like ESMD.
Subject Focus	risk management, communication, culture conflict, new technology, requirements issues, cost-schedule management.
Learning Points	Define risks in actionable ways. What everyone knows but no-one says can doom a project in subtle ways. Know what your test means and what success means before you conduct the test. Stick by the results of your test. Getting risks identified is the way to get them discussed.
Other Resources	VASA Museum website: http://www.vasamuseet.se/en/ Famous Failures: The VASA (PPT): www.cs.huji.ac.il/course/2003/postPC/docs/Famous_Failures_Vasa.ppt

Case Title	Lewis Spins out of Control
Project Name	Lewis
Source	NASA Safety Center (NSC)
URL	http://pbma.nasa.gov/docs/public/pbma/images/msm/lewis1_sfcs.pdf
# of Pages	4
Abstract	The Lewis Spacecraft Mission was conceived as a demonstration of NASA's Faster, Better, Cheaper (FBC) paradigm. Lewis was successfully launched on August 23, 1997, from Vandenberg Air Force Base, California on a Lockheed Martin Launch Vehicle (LMLV-1). Over the next three days a series of on-orbit failures occurred including a serious malfunction of the attitude control system (ACS). The ACS issues led to improper vehicle attitude, inability to charge the solar array, discharge of batteries, and loss of command and control. Last contact was on August 26, 1997. The spacecraft re-entered the atmosphere and was destroyed 33 days later. This mission may have been faster and cheaper, but in retrospect it was at the expense of better.
Subject Focus	“faster, better, cheaper” (FBC); on-orbit failure
Learning Points	Weak project management, a poorly articulated approach (FBC), and poor hardware/software verification can all lead to project failure. The NASA Lewis spacecraft serves as a cautionary tale for those proposing radical cost saving or cycle-time reduction techniques in complex space programs.
Other Resources	NASA Lewis Mishap Investigation Report (121998) NASA. http://spacese.spacegrant.org/Failure%20Reports/Lewis_MIB_2-98.pdf

Case Title	Lifting NOAA-N Prime
Project Name	NOAA-N PRIME
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	4
Abstract	NOAA-N PRIME was one of a series of polar-observing satellites used for weather prediction. While being rotated (vertical to horizontal) on a turnover cart for a routine procedure in the builder's facility the satellite fell off the cart, sustaining significant and costly damage. Complacency and poor management, planning, communication, and procedures contributed to a mishap that easily could have been avoided.
Subject Focus	risk management, communication, organizational silence, contractor issues
Learning Points	• Lax observance and control of even the most mundane, standardized procedures can have devastating consequences. • Safety and asset management always trump potential cost and schedule savings resulting from using unconventional or hasty procedures. • An organizational environment allowing for a "we do this all the time" modus operandi is a pretext for disaster. • Oversight of joint projects is every manager's first priority, whether contractor or government agency. • There is no substitute for onsite, visual inspection and verification. • Ignore at your peril engineering input from any level.
Other Resources	Mishap Investigation Board Report: URL: http://www.nasa.gov/pdf/65776main_noaa_np_mishap.pdf NOAA-N PRIME website: http://www.nasa.gov/mission_pages/NOAA-N-Prime/main/index.html

Case Title	Lost in Translation - The Mars Climate Orbiter Mishap
Project Name	Mars Climate Orbiter (MCO)
Source	NASA Safety Center (NSC)
URL	http://pbma.nasa.gov/docs/public/pbma/images/msm/MCO_SFCS.pdf
# of Pages	4
Abstract	The signal from NASA's Mars Climate Orbiter disappeared on Thursday, September 23, 1999. After a nine-month journey from earth, the spacecraft was moving into orbit around Mars when communications stopped. Ground software had miscalculated the spacecraft's trajectory. Instead of lightly skimming the Martian atmosphere, the spacecraft was orbiting more than 170 kilometers below its target altitude. Heat and drag from the atmosphere presumably destroyed the satellite.
Subject Focus	spacecraft trajectory; ground software
Learning Points	The proximate cause of the failure was a discrepancy between the use of English units vs. metric units in treating data from the ground navigation software. Underlying issues included the following: 1) the software interface control process and interface verification were not sufficiently rigorous; 2) communication between project elements was deficient; 3) the operations navigation team was unprepared, oversubscribed, and operating based on limited understanding of the MCO's specific design.
Other Resources	Listed at the end of the case study document

Case Title	Lost in Space: A Case Study in Engineering Problem-Solving
Project Name	Mars Climate Orbiter (MCO)
Source	National Center for Case Study Teaching in Science
URL	http://ublib.buffalo.edu/libraries/projects/cases/space/lost.html
# of Pages	8
Abstract	This four-part case deals with 1) making a case for space exploration (Part I: Exploration--Opportunity or Albatross?); 2) the rationale for going to Mars (Part II: Why Go to Mars?); 3) trying to land on Mars (Part III: Going to Mars—The Mars Climate Orbiter Mission) and 4) reviewing the findings of the Mishap Investigation Board (Part IV: Mars Climate Orbiter Mishap Investigation).
Subject Focus	engineering problem solving; "Faster, Better, Cheaper"
Learning Points	
Other Resources	

Case Title	Managing Knowledge and Learning at NASA and the Jet Propulsion Laboratory (JPL)
Project Name	n/a
Source	Harvard Business School Publishing
URL	http://hbr.org/product/managing-knowledge-and-learning-at-nasa-and-the-je/an/604S24-PDF-SPA
# of Pages	30
Abstract	Jet Propulsion Laboratory (JPL) faces a serious loss of knowledge--both because of the "faster, better, cheaper" mandate for Mars missions and from the retirement of key personnel. An extensive knowledge management system for NASA/JPL includes formal knowledge-capture mechanisms such as Web pages and digitized manuals and such informal ones as storytelling. The former are much easier to get funded and to implement than the latter, but chief knowledge architect Jeanne Holm is concerned that technology cannot solve some of the most difficult issues she faces. This case focuses more on managing the tacit knowledge held in the heads of scientists and experienced project managers than on the information technology that Holm has put in place. The switch from expensive but infrequent Mars missions to 2 missions every 26 months propelled a number of junior managers into positions of responsibility and decision making for which they had inadequate experience. In the face of increasingly tight budgets, Holm must decide what kinds of knowledge management initiatives to back--and how to encourage the cultural change that is needed in the organization.
Subject Focus	knowledge management; organizational learning
Learning Points	To highlight the challenges in managing the transfer of knowledge, both between experts and between projects.
Other Resources	

Case Title	Mechanical Systems Engineering Support Contract Re-Compete
Project Name	n/a
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	4
Abstract	Competitive procurement for providing mechanical, thermal, and other engineering services to Goddard's Applied Engineering and Technology Directorate in support of space technology development, Earth and Space Science missions, and NASA's Exploration Program resulted in a $400 million contract award, replacing the contractor in place for 25 years. This case looks at the very difficult contracting process and litigious aftermath that ultimately ended in success.
Subject Focus	culture conflict, contracts, contractors, communication
Learning Points	Responsibility to Government procurement policy and procedures, where does Government responsibility end in meeting procurement policy goals? How can Government procurement affect mission success now and in the future through unintended consequences relating to capabilities and workforce development. Thinking strategically in procurement, planning ahead, avoiding hostage situations.
Other Resources	

Case Title	M.S.T.I.: Optimizing the Whole System
Project Name	M.S.T.I.
Source	Virginia Polytechnic Institute
URL	http://www.nasa.gov/pdf/293212main_58529main_msti_casestudy_042604.pdf
# of Pages	27
Abstract	MSTI or Miniature Seeker Technology Integration tried to optimize over the whole project and not allow sub-optimizations to hinder the project. MSTI launched in 1992 and was managed by JPL.
Subject Focus	Systems engineering across a project
Learning Points	The importance of an aggressive schedule and working to the schedule to realize project level optimization of components and 'fast track procurement." Led to the Mission Design Center and System Test Bed at JPL.
Other Resources	http://www.fas.org/spp/military/program/test/msti.htm

Case Title	NASA After Challenger: Restoring an Image
Project Name	Challenger, STS-51L
Source	Harvard Business School Publishing
URL	http://hbr.org/product/nasa-after-challenger-restoring-an-image/an/591009-PDF-ENG?Ntt=challenger%2520
# of Pages	18
Abstract	In the days following the loss of the space shuttle Challenger and its crew in January of 1986, NASA officials were unwilling to communicate with the media or the public. A siege mentality took hold, and the press and public responded with intense criticism and inquiry. The case describes NASA's harmonious relationship with the media before Challenger, and the many obstacles William Sheehan faced when he stepped in to attempt to restore NASA's image and relationship with the media after Challenger. The issues include the special problems faced by a public institution with a history of poor internal communication, and the compounded difficulties of attempting to create effective internal policy while also trying to restore credibility with the media and deal with investigative probes.
Subject Focus	disaster management, media relations, management communication
Learning Points	
Other Resources	

Case Title	NEAR (Near Earth Asteroid Rendezvous)
Project Name	NEAR
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/flash/293123main_near_study.swf
# of Pages	n/a – self-learning multimedia presentation
Abstract	It's 1995. You're the Johns Hopkins University APL Project Manager and have been contracted by NASA for the NEAR mission. Near's Critical Design Review (CDR) has already passed, and everything's been designed and coded. You're right on target to meet the lofty goal of launching the spacecraft only 27 months from the mission's inceptions. Suddenly, you find out that a change to the mission has been proposed; several team members want you to make a modification to the missions XGRS instrument. They want this change because it would allow the NEAR mission to collect data on gamma ray bursts. They propose that you modify the software, the hardware, or both. But changing any of the hardware or software at this late stage in the project would have an impact on the science, the schedule, the budget, and the team. What are you going to do? What will you need to know to make your decision?
Subject Focus	redesign; managing change
Learning Points	
Other Resources	NEAR website at JHUAPL: http://near.jhuapl.edu/

Case Title	Pegasus XL-HESSI: Last-Minute Decisions in Flight-Based Launch
Project Name	HESSI
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	8
Abstract	The High Energy Solar Spectroscopic Imager (HESSI), a flight-based launch on a Pegasus rocket, was designed to provide high-resolution imaging of solar flares, which can damage satellites, radio communications, and power grids on Earth. Flight-based launches are dynamic, often hectic events for launch teams. The Pegasus XL-HESSI launch demonstrates why communication dropouts and a critical technical issue are still being debated during final countdown for a brief launch window.
Subject Focus	launch decision, communication, risk mgt.
Learning Points	Manage 'launch fever." The pressure to launch is immense the closer to the date. Understand the importance of pre-agreed criteria, what is critical and what is not. How a launch decision or scrub is made in real time. Slowing down for a caution sometimes means you will get stuck at the light.
Other Resources	HESSI web page: http://hesperia.gsfc.nasa.gov/hessi/

Case Title	Redesigning the Cosmic Background Explorer
Project Name	COBE
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/384131main_COBE_case_study.pdf
# of Pages	10
Abstract	COBE was slated to launch on the Shuttle in 1989 from Vandenberg Air Force Base. The Shuttle would place the satellite at an altitude of 300 kilometers, and an on-board propulsion system would then raise it to a circular 900 kilometer sun-synchronous orbit. The loss of the Space Shuttle Challenger 73 seconds after liftoff on January 28, 1986, changed everything. The Shuttle program's future was now uncertain and this had dramatic consequences across NASA, not only for the human space flight program. The COBE team was forced back to the drawing board.
Subject Focus	launch vehicle; redesign; matrix management; mass; co-location; test-as-you-fly
Learning Points	Since spacecrafts are designed based on pre-identified launch vehicles, a change in launch vehicles will likely result in a significant redesign, added costs and schedule slips. With the appropriate support at the Center level and from headquarters, financial and human resources can be applied to get things done and organizational structures can be re-aligned to fit the needs of a project. "Test as you fly" in order to catch problems before launch.
Other Resources	Cobe Satellite Marks 20th Anniversary - http://www.nasa.gov/topics/universe/features/cobe_20th.html

Case Title	Searching for Life on Mars: The Development of the Viking Gas Chronomatograph Mass Spectrometer
Project Name	Viking
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/384151main_Viking_GCMS_case_study.pdf
# of Pages	8
Abstract	The Viking mission was set to be the first mission to attempt as soft landing on Mars. The opportunity to conduct experiments on the planet's surface led to an extremely ambitious scientific agenda featuring thirteen scientific instruments. The primary objective of the Viking mission was to determine if there was evidence of life on Mars. In 1971, the project manager added the Gas Chromatograph-Mass Spectrometer (GCMS) to his "Top Ten Problems" list. While the project was managed from the Langley Research Center, the GCMS was the responsibility of the Jet Propulsion Lab (JPL). This arrangement failed to provide the desired results.
Subject Focus	instrument development; project management
Learning Points	Get the right technical expertise to solve technical problems; reach out to other industries and the private sector to identify solutions (even when they are proprietary); consider using a "Top Ten Problems" list to give visibility to challenges that could threaten the viability of the mission.
Other Resources	NASA's Viking webpage: http://www.nasa.gov/mission_pages/viking/

Case Title	Shuttle Software Anomaly
Project Name	STS-126
Source	NASA Safety Center (NSC)
URL	http://pbma.nasa.gov/docs/public/pbma/images/msm/STS-126_SFCS_revised.pdf
# of Pages	4
Abstract	A few minutes after the Shuttle Endeavour reached orbit for STS-126 on November 14, 2008, mission control noticed that the shuttle did not automatically transfer two communications processes from launch to orbit configuration. While the software problems did not endanger the mission, they caught management's attention because "in-flight" software anomalies on the shuttle are rare. This case looks at what happened, the proximate cause, underlying issues, as well as implications for future NASA missions.
Subject Focus	software anomaly; "test as you fly"; anomaly documentation
Learning Points	The STS-126 illustrates the need to ensure critical elements are embedded in design and procedures, provide sufficient training, complete rigorous end-to-end testing and verification, follow the oft-quoted mantra, "Test as you fly," and find the real causes of all anomalies.
Other Resources	"Flight Software Readiness." *STS-119 Joint Shuttle/Station Flight Readiness Review*. United Space Alliance Presentation, 02/03/09. "Space Shuttle Orbiter Systems." *HSF-The Shuttle*. http://spaceflight.nasa.gov/shuttle/reference/shutref/orbiter/ Fishman, Charles. "They Write the Right Stuff." *FastCompany.com*. 1996. http://www.fastcompany.com/magazine/06/

Case Title	Space Shuttle
Project Name	n/a
Source	Harvard Business School Publishing
URL	http://hbr.org/product/space-shuttle/an/909E09-PDF-ENG?Ntt=space%2520shuttle
# of Pages	6
Abstract	After the successful Apollo series NASA formulated a new vision for the space program, incorporating a space station and guaranteeing routine access to space via a reusable space shuttle. In 1986, the space shuttle design included two solid-rocket launchers which required the use of O-rings to seal the joints. After each launch the launchers were retrieved, inspected and possibly reused is they did not display evidence of O-ring distress. The space shuttle Challenger had flown 9 successful missions into space and was gearing up for its tenth with great fanfare due to NASA's successful public relations program, "The Teacher in Space Program". The evening prior to the January 28, 1986 launch saw representatives from the Kennedy Space Centre, the Marshall Space Flight Centre and contractor Morton Thiokol participate in a 3-hour teleconference to discuss if the predicted low temperatures would have any effect on the expected performance of the O-rings. In addition to the statistical analysis of the historical O-ring failure, the stakeholders needed to communicate their results in the appropriate flow of information.
Subject Focus	Behavior; human resources management; organizational behavior; organizational structure; quantitative analysis
Learning Points	
Other Resources	

Case Title	Space-to-Space communications System
Project Name	SSCS
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/384149main_SSCS_case_study.pdf
# of Pages	6 (+appendices)
Abstract	The Space-to-Space Communications System (SSCS) is a sophisticated two-way data communication system designed to provide voice and telemetry among three on-orbit systems: the Space Shuttle orbiter, the International Space Station; and the Extra Vehicular Activity Mobility Unit (EMU) (aka, the spacesuit). NASA decided to treat SSCS as an in-house development at the Johnson Space Center (JSC). Numerous organizational and technical challenges emerged over time while the project was under pressure to deliver the system for use on the Space Station. After encountering multiple failures on-orbit, the team was told to "fix it" and eventually had the time and resources to do it right.
Subject Focus	schedule pressures; testing; space communications; in-house development
Learning Points	Do it right the first time or you'll have to start over. Schedule pressures and organizational challenges can lead to band-aid fixes and equipment that isn't truly ready for flight.
Other Resources	http://www.nasa.gov/offices/oce/appel/knowledge/publications/SSCS.html

Case Title	ST5 - Miniaturized Space Technology
Project Name	ST5
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	4
Abstract	It was clear soon after the project began that the schedule for the ST5 (Space Technology 5) mission would be stretched regardless of how development of the complex technology proceeded, for one reason: the mission lacked a launch vehicle. Cancellation was a constant threat for a mission without an LV, and five years later, ST5—a demonstration project to test and flight-qualify innovative miniaturized technologies on three identical micro-satellites—is still in limbo, and project managers face the daily challenge of keeping the team focused on a mission whose fate is uncertain.
Subject Focus	distributed project; communication
Learning Points	Co-location of a project development team can be integral to mission success; Integrating the entire project team into the process, particularly in the case of distributed teams, should be a primary objective of the project manager; Consistently communicating the message that everyone's contribution is critical to the mission success is important; Regularly scheduled forums and open channels of communication between project management and team members, involving as many people as possible, is essential; In projects with new and inexperienced team members, the opportunity to mentor can help achieve success; Ensuring that team members clearly understand their roles and the importance of their jobs is critical, particularly on a project experiencing extensive delays.
Other Resources	Pause and Learn brochure: http://www.nasa.gov/centers/goddard/pdf/431367main_OCKO-Pal-Brochure-Rev_noLOGO.pdf NASA's ST5 website: http://www.nasa.gov/mission_pages/st-5/main/index.html

Case Title	STEREO: Organizational Cultures in Conflict
Project Name	STEREO
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	5
Abstract	The Solar Terrestrial Relations Observatory (STEREO) mission observes solar eruptions by imaging the Sun's coronal mass ejections from two nearly identical observatories simultaneously. The STEREO team includes members from Goddard Space Flight Center (GSFC), NASA HQ, the Johns Hopkins University's Applied Physics Laboratory (APL), and universities around the world. During STEREO's formulation and early implementation, cultural differences have arisen between APL and GSFC personnel. Project management from both APL and GSFC recognize this and address the challenge in a unique fashion.
Subject Focus	organization, institutional culture clash, communication, testing, schedule-cost management.
Learning Points	Teaming issues are worth addressing head on and early in the project lifecycle. Different cultures that partners bring can cause problems unless addressed and dealt with methodically like a project would deal with technical issues. Frequent attention to teaming issues can keep them from disrupting a team that spans different organizations. Clarifying roles and accepting roles is important for partnerships.
Other Resources	STEREO website: http://stereo.gsfc.nasa.gov/

Case Title	Stormy Weather: Lightning Strike on the Launch Pad
Project Name	Shuttle
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/externalflash/stormy_weather/index.html
# of Pages	n/a – self-learning multimedia presentation
Abstract	
Subject Focus	shuttle launch; decision-making
Learning Points	
Other Resources	

Case Title	Super Lightweight Tank: A Risk Management Case Study in Mass Reduction
Project Name	Space Shuttle Program
Source	NASA, Exploration Systems Mission Directorate
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	44 pages for the text version. See also the multimedia version (PowerPoint with embedded video clips).
Abstract	This case study exercise provides lessons learned from the development and operations of the Space Shuttle Program (SSP). It is intended to highlight key transferable aspects of risk management, which may vary slightly from a particular case study to the next. Transferable principles include the identification of risks, evaluation of risks, mitigation of risks, risk trades, and risk management processes. The proper application of risk management principles examined here can help manage life-cycle costs, development schedules, and risk, resulting in safer and more reliable systems for Constellation and other future programs. This case study format is intended to simulate the experience of facing the same difficult challenges and making the same critical decisions as the original managers, engineers, and scientists in the SSP. The case study will provide the background information and complementary data necessary to analyze the situation and answer the questions posed at key decision points in the case study. Solutions from the SLWT Team on what they actually did to solve the key decision questions are provided in the Appendices, followed by an Epilogue in which the actual decisions and outcomes are presented. The key lessons learned from conducting this exercise address how risks were identified, how they were evaluated, and how final choices were made.
Subject Focus	risk management, risk identification, risk mitigation
Learning Objectives	1. Developing risk identification skills 2. Understanding the broad range of control and mitigation options 3. Recognizing the power of collaboration - the "big brain" 4. Gaining experience in using powerful structured logic methods 6. Understanding challenges of introducing new technology
Other Resources	Teaching notes, multimedia version of the case.

Case Title	TDRSS: Fixed-Cost versus Cost-Plus Contracting
Project Name	TDRSS
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	7
Abstract	For the Tracking and Data Relay Satellite System (TDRSS), a series of geosynchronous communications satellites tracking low Earth-orbiting satellites and relaying the data to a single U.S. ground station, NASA awarded a fixed-price, leased-services contract. Numerous problems and requirements changes critically affected cost and schedule, and communications were strained between NASA, the prime contractor, and the subs. TDRSS offers excellent insight into the costs and benefits of both fixed-price and cost-plus award-fee contracting.
Subject Focus	cost-plus versus fixed-cost contracting, contractor issues, cost-schedule management., culture conflicts
Learning Points	Understand contract consequences; when the government doesn't own the asset, it doesn’t control its use. Commercial priorities will take precedence over science. Contracting choices will affect project for many years so be wary of short-term contracting solutions that have lasting effects on program viability.
Other Resources	TDRSS website: https://www.spacecomm.nasa.gov/spacecomm/programs/tdrss/default.cfm

Case Title	The CALIPSO Mission: Project Management in the "PI Mode": Who's in Charge?
Project Name	CALIPSO
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	10
Abstract	CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations), a joint mission between NASA and the French space agency CNES, was designed as a pioneering tool for observing Earth's atmosphere. Project development has been hampered for years by a complex organizational structure, management conflicts between NASA centers, international-partnership issues, and instrument and spacecraft problems—issues that appear to require a project replan.
Subject Focus	interagency communication, roles, relationships; ITAR and international partnerships
Learning Points	Define roles and responsibilities. Multiple centers, international partners, fixed price and cost-plus bring complexity to a project that needs addressing. Complex project structures have difficulty solving problems efficiently. Know when to push on HQ for definition and direction. Managing across borders and across contractors.
Other Resources	NASA CALIPSO website: http://www.nasa.gov/mission_pages/calipso/main/index.html

Case Title	The CEV Seat: Seeking a Semi-Custom Fit in an Off-the-Rack World
Project Name	CEV
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	7
Abstract	Developing a seat subsystem for the Orion crew exploration vehicle presented unique engineering challenges. With Preliminary Design Review approaching, the NASA engineer in charge of the project looked to the world of auto racing and "monster trucks" for innovation ideas, then undertook a hands-on approach to building a seat prototype
Subject Focus	contractor, requirements, engineering, schedule, review, learning
Learning Points	The innovation process of go wide in thinking, go practical in prototype and go thorough in testing. Using seemingly dissimilar fields (NASCAR) to improve NASA thinking. Challenges of parallel development when requirements are being specified on the fly in parallel iterations.
Other Resources	CEV Seat Attenuation System. URL: http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20070010702_2007005306.pdf

Case Title	The Dart Mission: Changing Environment, Shifting Priorities, Hard Decisions
Project Name	DART
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	6
Abstract	DART (Demonstration of Autonomous Rendezvous Technology) originated as a low-profile project to demonstrate that a spacecraft could rendezvous with a satellite without the assistance of ground control. The mission emerged, however, as NASA's "first flight demonstration of new exploration capability," the vanguard of the Vision for Space Exploration. With the high profile came high pressure. After a cost increase of more than 100 percent and schedule delays, DART failed halfway through its mission. Software development and testing in the guidance/navigation/control system, and inadequate systems engineering, were identified as causes. Could failure have been prevented?
Subject Focus	communication, contractors, engineering, instrumentation, ITAR, LV, politics, project management, roles, technical, technology, testing
Learning Points	Understanding the context of heritage hardware and software--how to verify and assure usage as accepted. The use of Lessons Learned and the danger of relying on LL without context and continued monitoring of application. Dealing with program changes, shifting risk postures and international partners.
Other Resources	DART MIB Overview Report http://www.nasa.gov/pdf/148072main_DART_mishap_overview.pdf

Case Title	The Million Mile Rescue - SOHO Lost in Space
Project Name	SOHO
Source	NASA Safety Center (NSC)
URL	http://pbma.nasa.gov/docs/public/pbma/images/msm/SOHO_SFCS.pdf
# of Pages	4
Abstract	The Solar Heliospheric Observatory Spacecraft (SOHO) is a major element of the joint ESA/NASA International Solar Terrestrial Program. Launched on December 2, 1995, it successfully completed its primary mission by 1997. After implementation of code modifications meant to increase SOHO's lifetime during its extended operations phase, multiple errors in the new command sequence repeatedly sent the spacecraft into an emergency safe mode. One key error remained undetected while ground controllers made a critical mistake based on an unconfirmed and faulty assumption. SOHO's attitude progressively destabilized until all communication was lost in the early hours of June 25, 1998. It took three months to miraculously recover and restore SOHO to full mission status.
Subject Focus	in space recovery; extending the mission; ground operations
Learning Points	The joint ESA/NASA Investigation Board (IB) determined that the mishap was a direct result of ground operations errors and that there were no anomalies on-board the spacecraft itself. Underlying issues included: 1) lack of change control; 2) failure to follow procedures; 3) overly aggressive task scheduling; 4) inadequate staffing and training.
Other Resources	Listed at the end of the case study document

Case Title	The NFIRE Launch: Beating the Sophomore Slump at the Wallops Range
Project Name	NFIRE
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	7
Abstract	NFIRE (Near-Field Infrared Experiment) is scheduled as the second orbital launch from the Wallops Flight Facility within five months, coming on the heels of TacSat-2. Two such launches in this timeframe from the small range on Virginia's Eastern Shore is ambitious. NFIRE is benefiting from lessons from TacSat-2, but problematic systems and other issues threaten the NFIRE launch, and could lead to destacking and launch delay. With the Range Readiness Review the next day, and launch two weeks away, the Range chief is prioritizing the issues in preparation for making a "ready" or "not ready" decision.
Subject Focus	choosing your biggest worry; launch decision making
Learning Points	Apply lessons learned on a quick turnaround. Fast pace (sounding rocket program) requires rapid learning and application of lessons learned. Deciding which problems are show-stoppers and which are not. Listening to the customer and being on the same risk-page. Who is taking the risk for certain decisions?
Other Resources	NFIRE web page: http://www.nasa.gov/centers/wallops/missions/nfire.html

Case Title	The Pursuit of Images of Columbia
Project Name	COLUMBIA
Source	Office of the Chief Knowledge Officer (OCKO), NASA/GSFC
URL	http://library.gsfc.nasa.gov/public/casestudies.htm
# of Pages	4
Abstract	Soon after the launch of Columbia STS-107, a piece of insulating foam struck the orbiter's left wing. Launch video did not reveal the extent of the damage, and engineers' analyses were inconclusive. The case follows the futile attempts of the chief structural engineer at Johnson Space Center to persuade upper management that obtaining images of Columbia's wing is critical to the safe return of ship and crew.
Subject Focus	communication, organizational silence, hierarchical barriers
Learning Points	The struggle of voicing a dissenting opinion in a hierarchical and fast moving organization. The challenge of being heard in a matrix organization. The need for clear assignment of responsibility to special teams- What is their report and to whom? The personal struggles of an engineer in getting heard.
Other Resources	Harvard Case: "Columbia's Final Mission" (Multimedia Case) http://hbr.org/product/columbia-s-final-mission-multimedia-case/an/305032-MMC-ENG Columbia Accident Investigation Board (CAIB) Report: URL: http://caib.nasa.gov

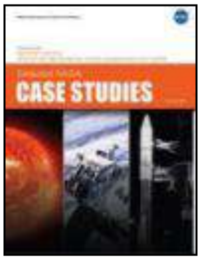
Case Title	The Tour Not Taken - NASA's Comet Nucleus Tour (CONTOUR)
Project Name	CONTOUR
Source	NASA Safety Center (NSC)
URL	http://pbma.nasa.gov/docs/public/pbma/images/msm/CONTOUR_SFCS.pdf
# of Pages	4
Abstract	The Comet Nucleus Tour (CONTOUR) mission is a story of lost opportunities and incomplete communication. The spacecraft was developed to gain insight into the nature of comets. While in orbit, CONTOUR fired its motor to put itself on the trajectory toward its first comet. During this time, the team did not schedule telemetry coverage, but they expected to regain contact once the burn was over. After many attempts to reestablish communication with CONTOUR, the project team officially declared the spacecraft lost.
Subject Focus	on-orbit failure; team integration; faulty design
Learning Points	CONTOUR illustrates the value of integrating with contractors and other organizations on a project team. The mission also illustrates the need to identify programmatic risk and in this case, to identify mission-critical events and provide telemetry data for these events. Telemetry tracking is critical for understanding a failed mission.
Other Resources	Listed at the end of the case study document

Case Title	Thermosphere Ionosphere Mesosphere Energetics and Dynamics Project (TIMED) Case Study
Project Name	TIMED
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/384153main_TIMED_case_study.pdf
# of Pages	21
Abstract	The TIMED mission was conceived around 1990 as a very ambitious multi-spacecraft mission. It was eventually launched on December 7, 2001 as a more modest mission with a single spacecraft. The program was caught in all the dramatic changes that NASA went through in this time period. At one point it came close to termination. The case study is presented in three distinct phases that characterize the development of the program.
Subject Focus	programmatic challenges; mission requirements; center buy-in; managing expectations; lines of authority; rules of engagement; complex relationships; personality conflicts
Learning Points	Phase One Lessons Learned: 1) It is necessary to recognize and respond to ground rule changes in a timely manner; 2) Control expectations; 3) Center buy-in and cooperation is necessary; 4) Basic mission requirements must be set early, prioritized, and maintained. Phase Two Lessons Learned: 1) Building and employing an ETU for a new hardware development is still a good idea. Phase Three Lessons Learned: 1) Clear lines of authority and reporting are necessary and must be followed; 2) The rules of engagement must be agreed to and put into writing; 3) A clear decision on the method of implementation of a project must be made and the relationship of the program and project defined for that method; 4) The Center must take ownership of any project for which it has responsibility and staff it accordingly; 5) Management processes appropriate for NASA funded projects need to be in place, verified and used no matter where the project is developed; 6) It is necessary to adhere to the processes developed for integrating and testing a spacecraft; 7) Co-manifesting multiple missions on the same launch vehicle is still an appropriate cost-saving technique but it should be employed within one Enterprise only; 8) Personality conflicts can be real and should be addressed and resolved to assure efficient functioning of the project team.
Other Resources	TIMED Mission website: http://www.timed.jhuapl.edu/WWW/index.php

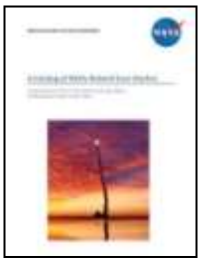
Case Title	Vegetation Canopy Lidar
Project Name	VCL
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/384157main_VCL_case_study.pdf
# of Pages	12
Abstract	The Vegetation Canopy Lidar (VCL) was selected in March 1997 as the First Earth System Science Pathfinder (ESSP) spaceflight mission. It was scheduled for launch in January 2000. Technology challenges (specifically with the Multi-Beam Laser Altimeter or MBLA) and project management challenges under the "PI-Mode" of mission management led to the mission being postponed indefinitely.
Subject Focus	weak project management & institutional oversight
Learning Points	1) A formal process utilizing a team of independent recognized experts for reviewing and approving project proposals is crucial to assure that only viable proposals are submitted; 2) The project selection process must not stop at the desirability of the science being proposed. It must include the viability of the mission implementation plan as well; 3) Managers leading a proposal effort must address the above considerations as part of their proposal preparation process; 4) The project management of a fast-paced low-cost mission requires a strong, yet streamlined, central management structure with short communication paths; 5) The management of a fast-paced, low-cost project still requires the project discipline necessary to assure that the project meets its technical and programmatic objectives; 6) The above two lessons learned imply that an experience project manager is highly desirable for any fast-paced low-cost project; 7) Projects involving a U.S. government entity, such as a NASA Center, as a subcontractor to an outside PI must formally document their subcontracting relatinoship; 8) Independent cost estimates or assessments must be done in conjunction with independent technical and managerial reviews.
Other Resources	VCL website: http://ilrs.gsfc.nasa.gov/satellite_missions/list_of_satellites/vcl__general.html

Case Title	Wide-Field Infrared Explorer (WIRE)
Project Name	WIRE
Source	Academy of Program/Project & Engineering Leadership (APPEL), NASA
URL	http://www.nasa.gov/pdf/384167main_WIRE_case_study.pdf
# of Pages	16
Abstract	The Wide-Field Infrared Explorer (WIRE) was meant to study the formation and evolution of galaxies. Its delicate telescope was sealed inside a solid hydrogen cryostat. Shortly after launch, a digital error ejected the cryostat's cover prematurely. As a result, hydrogen discharged with a force that sent the Small Explorer craft tumbling wildly through space. The subsequent investigation identified several opportunities, in review and testing, to have caught the fatal design error. Why wasn't it caught? Senior managers provide their insights.
Subject Focus	"faster, better, cheaper" mandate; geographically dispersed teams; communications;
Learning Points	Lessons highlighted in the case study include the following: 1) The proper application of Field Programmable Gate Arrays; 2) The importance of proper peer reviews of critical mission subsystems and components; 3) The importance of effective closed-loop tracking of system and peer review action items; 4) Greater care is necessary when managing a project across major organizational boundaries; 5) Extra vigilance is required when deviating from full system end-to-end testing; 6) System designs must consider both nominal and off-nominal solutions.
Other Resources	WIRE Mission Home Page http://sunland.gsfc.nasa.gov/smex/wire/mission/

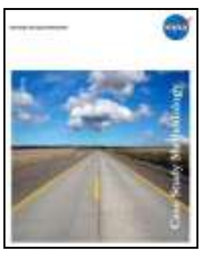
NASA/GSFC/OCKO Case Study Documents



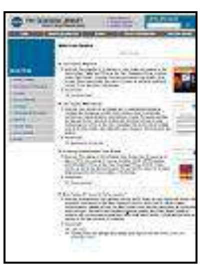
Case Studies Magazine
http://www.nasa.gov/centers/goddard/pdf/452484main_Case_Study_Magazine.pdf
This magazine is a collection of case studies put together by the NASA Safety Center and Office of the Chief Knowledge Officer, Goddard Space Flight Center. It includes four decision-oriented case studies, three system failure case studies, two cases of interest as well as a condensed version of the case study methodology.



A Catalog of NASA-related Case Studies
http://www.nasa.gov/centers/goddard/pdf/450420main_NASA_Case_Study_Catalog.pdf
This catalog of NASA-Related Case Studies lists cases from a range of sources, including NASA's APPEL program, NASA/Goddard's Office of the Chief Knowledge Officer, NASA's Safety Center, as well as the Harvard Business Review and the Center for Systems Engineering at the Air Force Institute of Technology.



Case Study Methodology
http://www.nasa.gov/centers/goddard/pdf/292342main_GSFC-Methodology-1.pdf
Case studies are an integral part of organizational learning at Goddard, used in workshops, conferences, training programs, and interactive media. This guide examines the rationale for the case-study method and describes the step-by-step methodology the Office of the Chief Knowledge Officer (OCKO) at Goddard uses to develop, publish, and implement cases studies in NASA missions and projects.



Digital Case Study Library
http://library.gsfc.nasa.gov/public/casestudies.htm
This repository of OCKO case studies includes cases that vary in length and focus.

Case Study Collections

NASA APPEL Case Studies
http://www.nasa.gov/offices/oce/appel/knowledge/publications/case_studies.html

NASA System Failure Case Studies
http://nsc.nasa.gov/KnowledgeManagement/SFCS.aspx

NASA Cases of Interest
http://nsc.nasa.gov/KnowledgeManagement/CasesOfInterest.aspx

Harvard Business School Case Studies
http://www.library.hbs.edu/hbs_cases.html

INSEAD (Institute European d' Administration des Affaires)
http://knowledge.insead.edu/find.cfm?ptypelist=8

Darden Business School, University of Virginia
https://store.darden.virginia.edu/business-case-studies

The National Center for Case Study Teaching in Science - Case Collection
http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm

ICMR Center for Management Research
http://www.icmrindia.org/Case%20Study%20Method.htm

European Case Clearing House (ECCH) Cases
http://www.ecch.com/about/Cases.cfm

The Electronic Hallway
https://hallway.org/index.php?PHPSESSID=n5cecejbgoupoae90sqoahpvu7

Stanford Graduate School of Business Case Studies
https://gsbapps.stanford.edu/cases/

Air Force Case Studies
http://www.afit.edu/cse/cases.cfm

Richard Ivey School of Business
http://cases.ivey.uwo.ca/cases/pages/home.aspx

Engineering Case Studies – Role-Hulman Institute of Technology, Carleton University
http://www.civeng.carleton.ca/ECL/5index.html

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